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(11) **EP 1 094 475 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.04.2001 Bulletin 2001/17

(51) Int. Cl.⁷: **H01B 13/02**

(21) Application number: **00305409.5**

(22) Date of filing: **28.06.2000**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: **29.06.1999 MX 9906133**

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(54) **Automatic pairing machine for automotive cable with electronic control and torsion method**

(57) An automated pairing or braiding machine for automotive cable which does not require cementation or special anchoring for its installation characterised by the design of its arrangements of: gripper actuated by a pneumatic or hydraulic actuator; a presser or holder of the pneumatic press type, which allows for the torsion of the cables in stretches cut to length in constant incre-

ments and operating with different cable diameters; and a headstock element with a system of points which operates with an actuator; and electronic sensor, protection, and control elements; and a method for applying torsion.

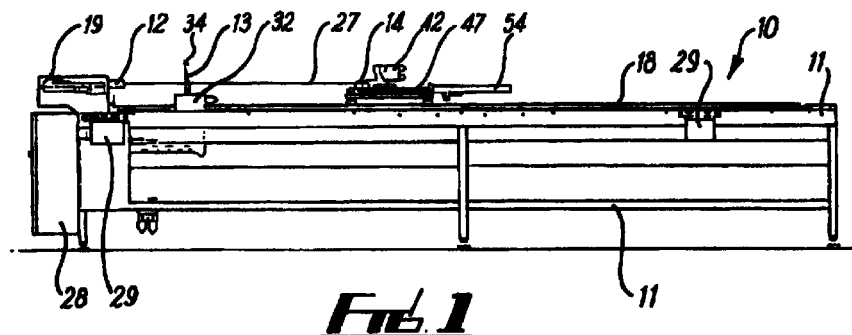


Fig. 1

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Description

BACKGROUND TO THE INVENTION

[0001] Various types of electrical conductor cable torsion machines are known to the prior art, commonly defined as braiding machines, which operate mechanically either by means of hydraulic mechanisms or pneumatic mechanisms, or both, such as, for example, in European Patent EP 0844 704 AZ, which describes a method for producing braided cables by means of a torsion machine with subsequent rotation of at least one of its holding elements or grippers, in such a way that the aligned wires are twisted together, while keeping them under tension. The rotation gripper may be mounted on a carriage, which is capable of being displaced axially in relation to the braiding trajectory between the holding grippers during the rotation process.

[0002] The function of this machine is characterised by a tension element, disposed on a carriage which moves in the axial direction of the torsion trajectory, and that when said carriage moves, the other tension element brakes with a predetermined force due to the reduction of the distance of the torsion trajectory during the braiding operation.

[0003] The Applicant has developed a pairing or braiding machine for automotive cables which does not require cementation or anchoring to the floor for its installation, characterised in that its gripper elements are actuated by a pneumatic actuator and a pressing element of the pneumatic press type which will allow for the torsion of the cables with the terminal applied at at least one end, in sections cut to length beforehand, with/without the terminals applied being provided at constant intervals, and operating in different combinations of diameters and terminals on said cables.

DESCRIPTION OF THE INVENTION

[0004] The invention is described hereinafter in accordance with Figs. 1 to 4, in which:

- Fig. 1 is a frontal view of the whole of the automatic pairing machine for automotive cables;
- Fig. 1a is a plan view of Fig. 1;
- Fig. 1b is a right side view of Fig. 1;
- Fig. 1c is a left side view of Fig. 1;
- Fig. 2 is a frontal view with a cross-section of a gripper module for pairing the cables;
- Fig. 3 is a frontal view with vertical longitudinal section of a pressing device for cable pairing;
- Fig. 4 is a frontal view with a cross-section of the headstock module or end pairing system;
- Fig. 5a is a view of a section of the backrest of the headstock;
- Fig. 5b is a frontal view of the carriage. Support for the presser.
- Fig. 5c is a right side view of the carriage for the

presser and the headstock;

Fig. 6 shows the electrical circuit diagram for the control and power system for the pairing machine.

[0005] Fig. 1 shows the assembly of principal modules of the automatic pairing machine for automotive cable 10, said principal elements being:

[0006] A frame structure 11 of the extended type, consisting of a rigid frame constructed of conventional commercially available profile structures, capable of supporting the entire weight of all the additional components, and providing the machine with the rigidity necessary to support the continuous operation of the system. Installed on this are all the principal elements and supplementary components which will allow for the operation of the equipment: Air pressure regulators, tensioning devices for lines and hoses, electric valves, motors, ribbon cables, cables, etc.

[0007] In the upper part of the frame 11 is a platform 17 with metallic cladding, Fig. 1a, on which are located a pair of guide bars 18, Fig. 1a, disposed symmetrically longitudinally along the entire length of the cover 17.

[0008] As the first modular element, disposed at the left end of the platform 17 of the frame, there is a fixed module, the gripper element 12, Fig. 1, which operates with a gripper actuator 19, and consists of a hollow shaft 20, Fig. 2, which houses the gripping mechanism, actuated for closure by an internal spring (adjustable) 21, and for opening by said actuator 19, either pneumatic, hydraulic, or electrical. The actuator 19 is located axially to the hollow shaft 20, by means of an opening coupling element 31. The hollow shaft 20 is mounted on roller bearings 22 and is driven in turn by a set of pulleys 23, a toothed or flat vee-belt 24, a gripper motor 25 for the transmission of movement, and an actuating shaft 26 disposed in the centre of the hollow shaft.

[0009] The principal function is to grasp the ends of the cable 27 which is to be paired, Fig. 1, whether this has terminals or not, and to apply to it the torsional forces necessary to result in pairing. This component varies the speed in order to vary the increment of the pairing. In Fig. 1c can be seen the left side cover element 15, with the panel 28 for the electronic control elements. In Fig. 1b can be seen the right cover element 16, in which is disposed the electric button panel 29 and the carriage motor 30, to provide for the longitudinal displacement movement of the carriage on the platform 17.

[0010] As a second modular element, disposed on the platform 17 and located between the gripper 12 and the headstock 14, is a presser module 13, with dynamic longitudinal displacement above the guide bars 18 by means of a carriage 32 in which the presser consists of a C-type structure with a main frame 37, mounted on an adjustable base 38, in which are located a set of rollers 33, Fig. 3, actuated by a pneumatic actuator 34, which trap and grip between them the pair of cables 27, Fig. 1a, which are to be paired. This has two principal func-

tions: first, to keep the cables parallel immediately prior to their being paired; and, second, to avoid the torsional movements applied by the gripper from extending as far as the headstock module 14, Fig. 1, concentrating solely on the gap which exists between the gripper and the presser modules. The pair of rollers 33 are moved by means of bearing elements 35 and 36.

[0011] As mentioned heretofore, the carriage 32 is responsible for providing longitudinal movement to the presser module such that its displacement is effected in a co-ordinated manner with the revolutions of the gripper. The increment of the pairing operation depends on the relationship between these modules. The carriage always has a constant speed in such a way that in order to vary the increment of the pairing operation in reality the revolution speed (RPM) of the gripper is varied.

[0012] The presser assembly is mounted on a carriage 32, Fig. 5b, which is provided with wheels 52, Fig. 5c, which run across the guide bars 18 located in the upper part of the frame 11, Fig. 1, and is driven by a motor 30 and a set of toothed pulleys 53, Fig. 1b, which provide movement for the carriage by means of a continuous toothed belt 39.

[0013] The carriage has two basic positions: the initial (HOME) position, which is located adjacent to the gripper 12, and the carriage end position (END), which is always determined by the final position of the headstock 14 when the cable has been paired.

[0014] Both positions are determined by the cams for actuating the microswitches. Located in the upper part of the carriage 32 is the cam 48, Fig. 5b, which actuates the END microswitch. In the rear part of this is the cam 48, Fig. 5b, which actuates the HOME electrical sensor element 50, Fig. 5b.

[0015] A rubber end stop 49 is disposed on the face of the carriage.

[0016] As a third principal modular element, disposed above said platform 17 and located at the opposite end of the gripper, is the headstock module (system of points) 14, Figs. 1 and 4, with longitudinal displacement on the guide bars 18.

[0017] The headstock module is a dynamic arrangement with an "L" type structure 40, Fig. 4, held by a locking plate 51, and a runner 41, with slides 47, which moves longitudinally to the platform 17. Integrated in said structure is a motor 42, Fig. 4, in the upper part, to transfer movement by means of a belt 43 to the system of (torsion) ends 45 by means of a set of pulleys 44; additionally, a pneumatic actuator device 46 is disposed at the end opposite the cable ends, which likewise includes on the outside a carriage limit sensor (END) 51, Fig. 5a.

[0018] This module is the only arrangement which is capable of adjustment in any position along the length of the platform 17. The headstock is an operating element which is very important during the pairing process, and performs various functions during the pairing operation. First, it is required to grasp one of the ends of the

cable and hold it during the pairing procedure, it being required to compensate individually on each cable end for the torsion forces generated by the gripper; and finally by means of a pneumatic actuator it performs two additional functions; it maintains a constant tension on the lines and compensates for the contraction which the cables undergo as a result of the pairing increment.

[0019] The principal motor 42 induces movement at two universal joints by means of a triangular pulley arrangement. Each of the universal joints carries mounted on the outside an interchangeable tool in a convergent arrangement into which the different types of cable ends are inserted.

[0020] With regard to the tension which is exerted by the headstock, this can be adjusted by means of the pressure regulator located on the protective casing 54, Fig. 4, of the pneumatic actuator 46.

[0021] The following devices are provided as additional elements:

Electrical control and power panel 15, Fig. 1c

[0022] The control and power panel contains the elements necessary to carry out the control of the process and provide electrical protection for its components. Set out below is a description of the electrical components of the panel and of their use in the function of the equipment, in accordance with the circuit diagram in Fig. 6.

Protection elements

[0023]

"GK2CF16"	Circuit-breaker, with thermal and magnetic fuses for the power supply to the speed adjusters.
"GB2CD08"	Circuit-breaker, with thermal and magnetic fuses for the power supply to the control circuits.
"K1"	Contactor LC1D0910, used to cut the power supply to the speed adjusters.
"K2"	Contactor LC1D0910, used to energise the carriage speed adjuster.
"K3"	Contactor LC1D0910, used to energise the gripper speed adjusters.
"R"	Control relay 700-HK36A1, used to indicate to the PLC the presence of power at the adjuster element.

Control elements

[0024]

"PLC"	Consisting of the codes 1746*4, 1746P2, 1747L532, 17461B16, 1746OX8, and 1746NIO4V. This equipment is responsible for dealing with the tasks required to
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control the process, carry out the connection between the pneumatic and electrical components, and coordinate the relationship between the speeds of the carriage and the gripper.

- "I" Speed adjuster 514C, responsible for controlling the movement of the gripper.
- "II" Speed adjuster 514C, responsible for controlling the movement of the carriage.
- "507" Speed adjuster 507/06/10, responsible for controlling the movement of the headstock.
- "30310K1" 10 kΩ potentiometer, used to adjust the speed of the headstock.

[0025] Located in the main part of the panel are the dialogue elements. A red flashing pushbutton (DE-ENERGIZE SYSTEM), a green flashing pushbutton (ENERGIZE SYSTEM), and a four-position selector (PAIRING SPEED).

Dialogue interruptors (keypads) 16

[0026] These are located above the front face of the machine. The first of them on the left (fixed) and the second on the right-hand side (adjustable) contain 6 and 4 flashing pushbuttons respectively, with the following legends and functions:

- Emergency stop with locking device (red)
If this button is actuated, the machine will entirely suspend the task which it is carrying out at that moment. Once actuated, it is necessary for it to be reset to its initial position before the system is restarted (unlock). To do this, actuate the system from the main control panel with ENERGIZE SYSTEM.
- Start cycle
When this button is actuated, the pairing sequences will commence, provided that the correct steps and sequences have been followed.
- Return carriage
This button fulfils two principal functions: First: During the setting-up of the machine, when, after the presser has been lowered, it is required to lift it again to release the cables. Second: During the pairing cycle, or once this has been completed, actuation of this button will result in the carriage returning to the initial position. It should be mentioned that if the carriage is returned while the cycle is in progress the response from the system will be to stop the pairing rotation, return the carriage to its initial position and to open the gripper in order to release the cable ends.
- Open gripper
During the preparation phase this serves to open the gripper in the event of the erroneous mounting of the cable ends. If the presser has been lowered

actuating this button will first release the presser and then the gripper.

- Close gripper
This button allows for the gripper to be closed during the preparation of the machine.
- Lower presser
Pressing this button causes the gripper to be lowered during the preparation of the machine.

Likewise included are elements which require adjustment in order to establish the operating conditions, which are as follows:

[0028] HOME position microswitch, 50, Fig. 5 b. This element determines the stopping of the carriage when returning to its initial position. It only has a degree of freedom of movement in the rising-descending direction, and must be adjusted in order to allow for smooth actuation with the cam located on the carriage.

[0029] HOME microswitch cam, 48, Fig. 5b. This cam is located in the rear part of the carriage. It only has a degree of freedom of movement in the longitudinal direction. Its setting position is determinant for the final position of the carriage at the HOME end. Setting the cam entirely to the right will cause the carriage to stop before coming in contact with the cover of the gripper. Setting the cam entirely to the left will result in delayed stoppage of the carriage.

[0030] END position microswitch, 51, Fig. 5a. This element is located on the right-hand side of the headstock. It is actuated by the cam located in the upper part of the carriage, and its actuation is responsible for the total stoppage of the gripper and headstock motors. It only has a degree of movement in the rising-descending direction, and must be adjusted in order to allow for smooth actuation by the cam.

[0031] END microswitch cam, 48, Fig. 5b. This is located in the upper part of the carriage. This must be aligned in order for the correct actuation of the END microswitch to be guaranteed. Its adjustment is determinant in setting the premature or delayed stopping of the carriage and headstock. Setting it entirely to the right will cause the premature stopping of the motors, obtaining a length without pairing which is greater than that specified. Setting entirely to the left will incur the delayed stopping of the motors, causing closure of the pairing phase or excessive torsion on the cable ends at the end of the headstock.

[0032] Headstock potentiometer. This is located inside the electrical panel and in the upper part of the driver 507/01/10, and serves to monitor the revolution speed of the headstock. The potentiometer shows a scale from 0 to 100, with a speed range from 0 (0) to 1700 (100) RPM. A higher setting on the potentiometer will eliminate torsion at the end of the gripper, directly affecting the pairing increment. A lower setting will close the increment at the end of the headstock.

[0033] Headstock base. This is a rigid frame on which the headstock slides in order to compensate for

the contraction of the paired cable. With the aid of four annular knobs it is possible to set the operational position for this base element on the guide bars. Its setting position is determinant in the headstock being able to absorb the total contraction of the cable.

[0034] The contraction of the cable depends on the initial length, the diameter, and the pairing increment. The contraction for each individual case should be determined empirically, and on the basis of this the position to be adopted at the outset should be determined.

[0035] Indicator ring. Mounted on one of the headstock base guides is an indicator ring. This element serves to establish the basic adjustment conditions. For each cable which is installed and tensioned on the machine, this ring should be turned to the right until contact is established with the linear bearing of the headstock. When pairing is being carried out, the ring is displaced by the bearing as a result of the constriction. When the pairing cycle is completed, the headstock can move back to the rear part of the guides (moved manually), but the ring will remain showing the maximum constriction of the cable. In this way with a simple subtraction between the initial position and the final position of the ring it is possible to determine the actual constriction of the cable and to predetermine the amount of run available which must pertain as a minimum.

[0036] Tension regulator. This is a pneumatic pressure regulator which is located between the protective cover 54, Fig. 4, of the pneumatic actuator of the headstock and serves to regulate the tension to be applied on the lines.

[0037] Interchangeable points. These are a pair of grooved and interchangeable points which must be installed in the headstock. Depending on the type of terminal and the diameter of the wire the most appropriate set of points must be fitted to suit the operation.

[0038] Scale. This serves to provide a reference for the basic position of the headstock and to record data for the initial lengths and degrees of contraction.

[0039] Torsion method

1. The process starts with the carriage located at the left end of the machine and by activating the HOME microswitch 50, Fig. 5b, both the gripper and the presser are opened.
2. The pair of cables are introduced into the machine, always starting with the headstock end. The cable ends are inserted one at a time into each tool. The cables are kept in parallel laying them as far as the end of the gripper.
3. In order to keep both lines taut and in line, the ends are inserted, with or without terminals, between the grippers and are aligned above the longitudinal grooves which are located on the inside faces. If necessary the gripper must be positioned manually in such a way that the manner in which the cable ends are to be inserted can be seen in

detail. Once this has been done, the CLOSE GRIPPER pushbutton is actuated.

4. If insertion is incorrect, both ends will be gripped, and OPEN GRIPPER is actuated; the previous step is then repeated until successful preparation is achieved.

5. LOWER PRESSER is activated, and a check is made to ensure that both cables remain well tensioned in order for the headstock to be moved, and for the cables to be held within the slot formed by the rollers. If gripping with the presser is incorrect, actuating RESET CARRIAGE will cause the presser to be lowered and/or tension to be released, and the operation is repeated.

6. START CYCLE is actuated. At this point, the gripper and the headstock will start to rotate simultaneously, and the carriage will start to move to the right. The gripper will turn clockwise, while the headstock will turn anti-clockwise.

If START CYCLE is actuated without the presser having been lowered beforehand, the system is programmed to carry out this instruction automatically before the braiding cycle is started.

7. When the carriage reaches the headstock end the END microswitch must be actuated and all the motors stopped. One second later the presser will automatically be released and then the gripper. Accordingly the release of the cable ends at the gripper end will be automatic.

8. The end of the cable is withdrawn by the side of the headstock and RESET CARRIAGE is actuated. The carriage will return to the starting position and will remain ready for a new cycle.

9. Restart the cycle.

Special conditions

[0040]

10. In the event of an error or a minor problem during operation RESET CARRIAGE may be actuated on any keypad. All the motors will then stop, the presser will open automatically and the carriage will start to be reset which will continue until it reaches the starting point (HOME) when the gripper will open automatically and release the cable.

11. In the event of an accident EMERGENCY STOP is actuated and the entire movement system will immediately cease operating, although the gripper and the presser will remain closed. When the system is restarted (releasing the pairing lock system) the system will take up the reset carriage routine; i.e. the presser will open and the carriage will move into the HOME position. When HOME is reached the gripper will open automatically.

[0041] As described the invention is considered as a novelty and accordingly the content is claimed of the

following:

Claims

1. An automatic pairing machine for automotive cables with electronic control consisting of a rigid extended bench structure to accommodate the following modules:
 - Fixed module of gripper gripping elements; presser elements module, mounted on a carriage capable of sliding horizontally for gripping cables during the pairing or braiding process; headstock module in which the system of cable ends is retained in a sliding carriage running on guide bars; and additional elements such as the electrical and power control panel and dialogue interruptors, characterised in that the structure of the bench provides, in the upper part of its base a platform with longitudinal guide bar elements to support the following modules: The fixed gripper module, which is a mechanical arrangement designed as a head piece at the front end of the platform, and is integrated by means of a hollow shaft which accommodates the gripper mechanism to hold the ends of the cable which are to be paired, a presser module integrated in a dynamic carriage which slides longitudinally on the guide bars and the elements of a system of rollers disposed on the carriage to hold the cable; a headstock module disposed at the back end of the platform with longitudinal displacement over the guide bars being an electromechanical arrangement of a system of convergent points to hold the ends of the cables and to effect the pairing procedure disposed above a structure which in turn is supported by a sliding platform.
2. An automatic pairing machine for automotive cables with electronic control according to Claim 1 characterised in that the gripper module is a mechanical arrangement supported on a rectangular structure, consisting of: A hollow tubular shaft within which is disposed the gripper mechanism featuring at its rear end gripping elements which are actuated by closure with a spring element disposed coaxially above the hollow shaft and adjusted by means of a spring adjuster element which coincides with one of the ends of the spring; and with the opening of the gripper being effected by means of an actuator, either electrical, hydraulic or pneumatic, disposed co-axially at the left end of the hollow shaft by means of a cylinder adapter and a coupling element, said hollow shaft being mounted above two roller elements secured to the rigid structure and with the mechanism being actu-

ated by a motor system, a set of pulleys and a toothed or synchronised or trapezoidal belt (vee-belt); and external elements in the form of electrical pushbuttons for controlling starting and stopping.

3. An automatic pairing machine for automotive cables with electronic control according to Claim 1 characterised in that the presser carriage module is a mechanical arrangement with longitudinal displacement above the guide bars of the platform and is disposed between the gripper and the headstock module, said arrangement consisting of a rigid vertical structure in which are accommodated a set of rollers supported on bearings, allowing for passage between said rollers which meet one another in order to grip the cables which are to be paired, the rollers being actuated by a pneumatic actuator disposed in the upper end of the presser; a dynamic carriage with an adjustable base which supports the pressing system and comprises a motor system, and a set of toothed pulleys and a toothed belt for its horizontal displacement; and external electronic pushbuttons for its operational control.
4. An automatic pairing machine for automotive cables with electronic control according to Claim 3, characterised in that the presser mechanism keeps the cables parallel to one another before they are paired and avoids the torsion forces applied by the gripper mechanism from reaching as far as the cable ends mechanism, concentrating said forces solely in the stretch between the gripper and the presser element, the displacement of the presser being longitudinal and co-ordinated with the revolutions of the gripper, the pairing increment being dependent on this synchronised relationship.
5. A pairing machine for automotive cables with electronic control according to Claim 3 characterised in that the carriage is integrated by means of a platform structure, the upper part of which is provided with a stop cam (advance), while the lower part has a stop cam (withdraw), the front features a cover element and the opposite end is provided with electronic sensor elements for the starting point.
6. A pairing machine for automotive cables with electronic control according to Claim 1 characterised in that the headstock module is a mechanical arrangement of a rigid structure holding a locking plate which incorporates a motor system in an upper end, based on a motor and an arrangement of pulleys and belts, which actuates the system of points or the torsion of the cables to be paired, as well as being activated by a pneumatic actuator device disposed in the opposite end to said points, including an end-of-run sensor on the exterior, mounted on a platform with runners.

7. An automatic pairing machine for automotive cables with electronic control according to Claim 6 characterised in that the system of points, being one pair of notched and interchangeable points as a function of the type of terminal and the diameter of the cable which is to be subjected to torsion. 5
8. Method of applying torsion to automotive cable in a pairing or braiding machine according to Claims 1 to 7, characterised by the phases of: 10

the carriage being located at the left end of the machine, actuating the HOME microswitch and the gripper and presser remaining open;

pairs of cables being introduced into the machine through the end of the headstock and the ends being inserted one into each tool and then conducted as far as the gripper end; the ends being aligned above the notches and the CLOSE GRIPPER pushbutton being actuated once correct insertion has been confirmed; LOWER Presser button being actuated and gripping being confirmed inside the notch or passage formed by the rollers;

START CYCLE button being actuated and the gripper and headstock modules starting to rotate simultaneously and the carriage moving to the right, turning the gripper in the direction opposite to that of the headstock;

when the carriage coincides at its end with the headstock, the END microswitch actuates and stops all the motors; almost immediately thereafter the presser is automatically released and then the gripper;

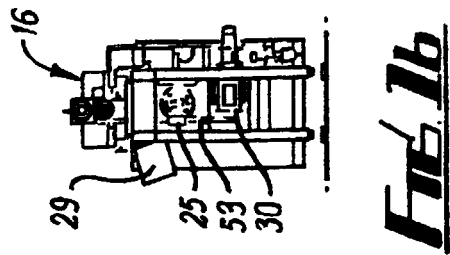
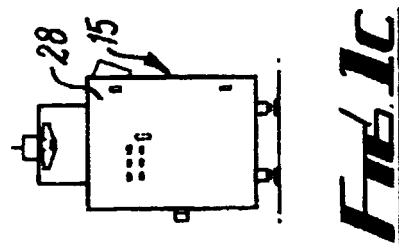
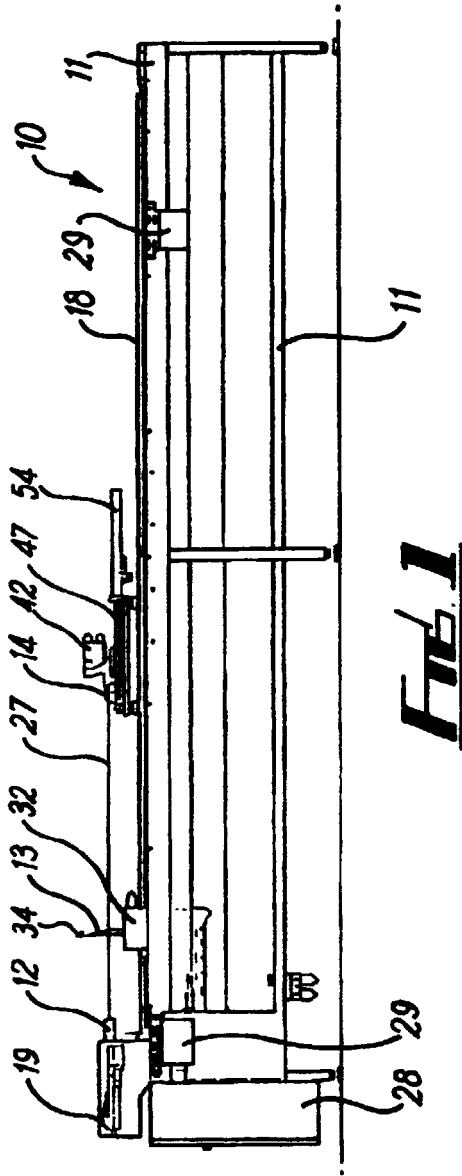
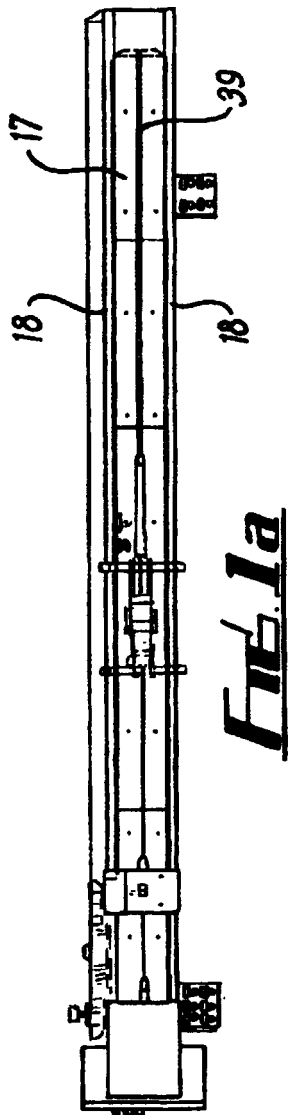
the end of the cable is recovered through the side of the headstock and RESET CARRIAGE is actuated, the carriage then returning to the starting position and remaining ready for another cycle.

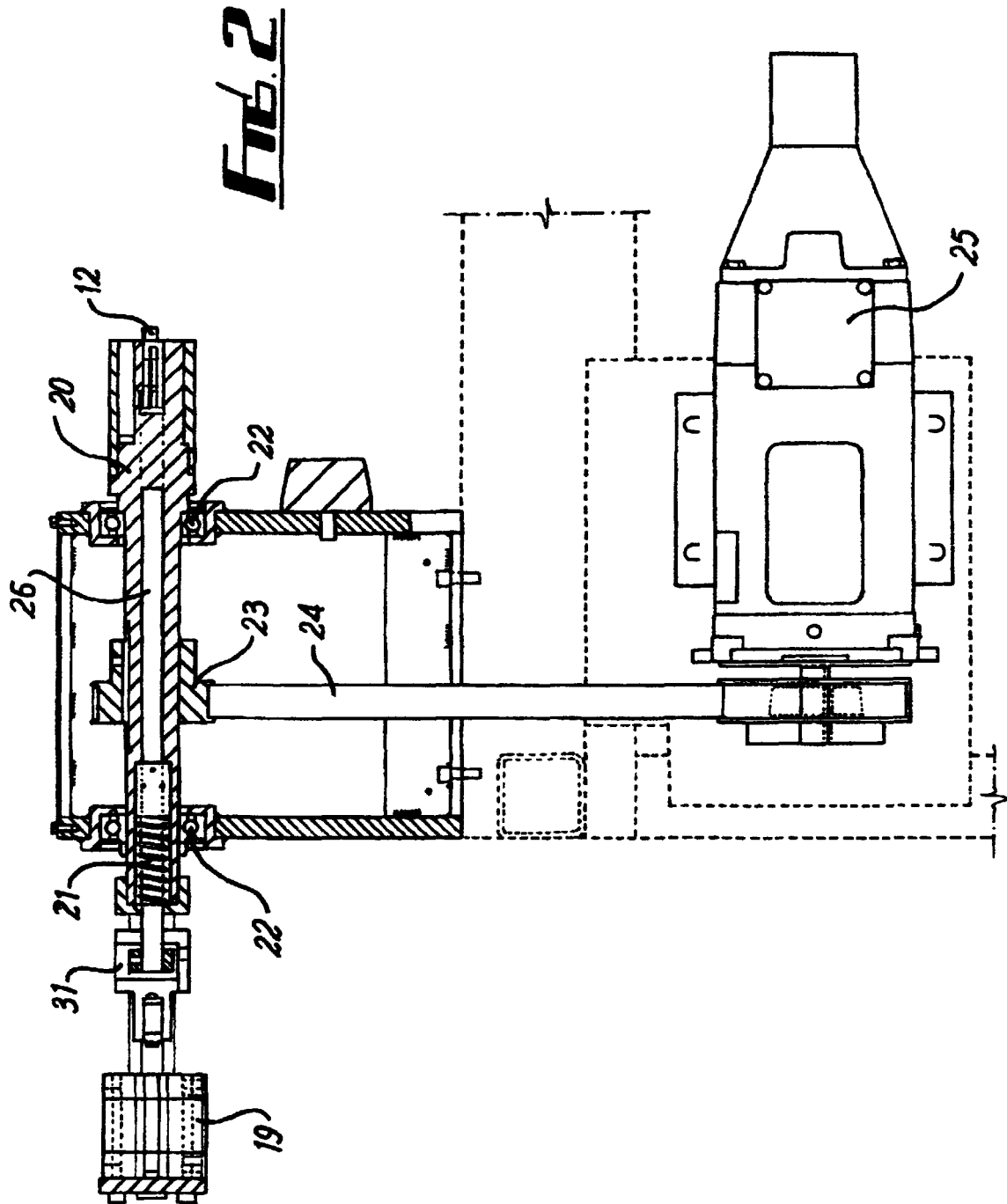
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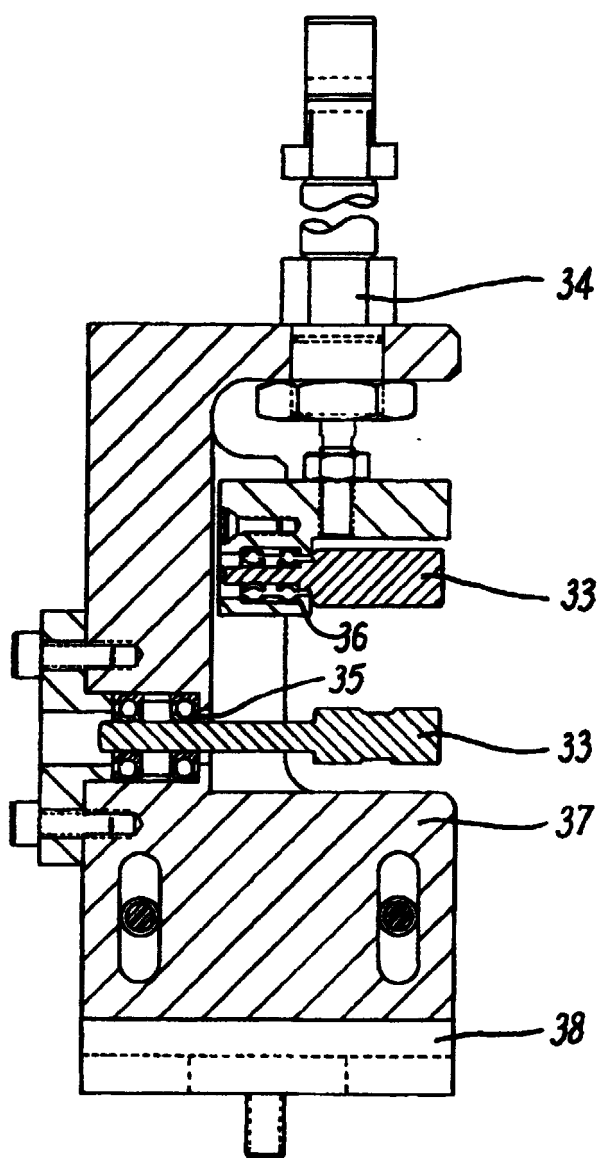


FIG. 3

